

MASSACHUSETTS SHIFTING SHORELINES

NEW DATA ON SHORELINE CHANGE

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Understanding shoreline change is essential for protecting public health and the environment in coastal communities. These shoreline change maps are an important tool for understanding how much, how fast, and why these changes are occurring.

*-Bob Durand,
Environmental Affairs Secretary*

Coastal shorelines change constantly in response to wind, waves, tides, sea level fluctuation, seasonal and climactic variation, human alteration, and other factors that influence the movement of sand and material within a shoreline system. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions.

To help make informed and responsible decisions, coastal managers, shorefront landowners, and potential property buyers need information on both current and historical shoreline trends, including reliable measurements of erosion and accretion rates in non-stable areas. The

A word of caution to shorefront landowners, potential buyers, and others interested in this information as it relates to a particular property—the Shoreline Change Project presents both long- and short-term shoreline change rates at 40-meter intervals along the entire Massachusetts coast. In a broad sense, this information may provide useful insight into the erosional forces at work along the Massachusetts coast. But care must be used when applying this information to specific property or local sections of coastline. Due to the multitude of natural and human-induced factors that can influence shoreline position over time, correct interpretation of the data requires an



Shoreline change, particularly the erosion of coastal bluffs, can have tremendous consequences for structures located too close to the action—like the homes and lighthouse seen along the Siasconset area on Nantucket's southeastern corner.

goal of the Massachusetts Office of Coastal Zone Management (CZM) Shoreline Change Project is to develop and distribute scientific data that will help inform local land use decisions. This fact sheet explains the process of shoreline change and discusses its impacts, summarizes the CZM Shoreline Change Project, and explains how to interpret information contained in the shoreline change maps and data tables.

in-depth knowledge of coastal processes. Those without extensive backgrounds in coastal geology, while encouraged to explore the historical migration of Massachusetts shorelines, are strongly advised to consult with a professional when attempting to use the Shoreline Change Project data for planning purposes. In no case should the long-term shoreline change rate be used exclusively before the short-term rates and contributing factors are understood and assessed.

HOW AND WHY SHORELINES CHANGE

As the waves gently lap the shore of a beautiful stretch of sandy beach, do you ever wonder where that sand came from? The answer is: **erosion**. The source of the sand that created and continues to feed the beaches, dunes, and barrier beaches in Massachusetts comes primarily from the erosion of coastal landforms. For example, the material eroded from the Atlantic-facing coastal bluffs of the Cape Cod National Seashore supplies sand to downdrift (i.e., down current) beaches of the Cape.

Erosion, transport, and the accretion that results are continuous and interrelated processes. Every day, wind, waves, and currents move sand, pebbles, and other small materials along the shore or out to sea. Shorelines also change seasonally, tending to accrete slowly during the summer months when sediments are deposited by relatively low energy waves and erode dramatically during the winter when sediments are moved offshore by high energy storm waves, such as those generated by northeasters.

SHORELINE CHANGE AND COASTAL PROPERTY

Given its aesthetic and recreational appeal, the Massachusetts coastal zone has been and continues to be subject to intense development. Much of this development is susceptible to on-going risks from winds, waves, storm surge, flooding, relative sea level rise, and the associated erosion of coastal landforms. Consequently, shoreline change is an important issue in Massachusetts.

While erosion and flooding are necessary and natural, they do have the potential to damage coastal property and related infrastructure, particularly when development is sited in unstable or low-lying areas. These dynamic and powerful processes can expose septic systems and sewer pipes, contaminating shellfish beds and other resources; release oil, gasoline, and other toxins to the marine environment; and sweep construction materials and other debris out to sea. Public safety is also jeopardized when buildings collapse or water supplies are contaminated.

Shoreline change can result in significant economic and emotional loss in a system of fixed property lines and ownership. Attempting to halt the natural process of erosion with seawalls and other hard structures, however, simply shifts the problem, subjecting downdrift property owners to similar losses. Also, without the sediment transport associated with erosion, some of the Commonwealth's greatest assets and attractions—beaches, dunes, barrier beaches, salt marshes, and estuaries—are threatened and will slowly disappear as the sand sources that feed and sustain them are eliminated.

The challenge, therefore, is to site coastal development in a manner that allows natural physical coastal processes, such as erosion, to continue. To meet this challenge, coastal managers, property owners, and developers must work with erosion—not against it—by understanding the magnitude and causes of erosion, and applying appropriate management techniques that will allow its beneficial functions to continue.

THE CZM SHORELINE CHANGE PROJECT

In the previous phase of the Shoreline Change Project, CZM completed a statistical analysis from the mid-1800s to 1978 for Massachusetts' ocean-facing coastline and produced 76 maps showing several historic shorelines to demonstrate long-term shoreline change. CZM distributed these maps to coastal conservation commissions in 1997, helping local decision makers identify coastlines that are prone to storm damage and significant erosion and to assess erosion potential. CZM recently completed an update of the Shoreline Change Project, using 1994 National Oceanic and Atmospheric Administration (NOAA) aerial photographs of the Massachusetts shoreline. CZM established an agreement with the U.S. Geological Survey (USGS), the Woods Hole Oceanographic Institution (WHOI) Sea Grant Program, and Cape Cod Cooperative Extension (CCCE) to produce a 1994 shoreline, add it to the previous project, and update the statistics and calculate erosion rates. The work was



conducted by Rob Thieler and Courtney Schupp at the USGS and Jim O'Connell at the WHOI Sea Grant Program and CCCE. The new maps and statistical analysis of shoreline change now cover the time period from the mid-1800s to 1994.

The 1:10,000 scale shoreline change maps show the relative positions of four or five historic shorelines and depict the long-term change rate at 40-meter (approximately 131-feet) intervals along the shore. In all, 30,300 transects were constructed and used in the statistical analysis. Data tables that accompany the 76 shoreline change maps also show the short-term shoreline change (i.e., the change between successive historic shorelines), the total landward or seaward change in distance, and the long-term shoreline change rate for each transect.

It is **very** important to note that due to necessary adjustments in the baseline for this project, the location of current transect numbers are not consistent with those reported on the 1997 shoreline maps or data tables.

Therefore, shoreline rates of change noted at the end of numbered transects on these shoreline change maps and data tables should not be compared directly with previous numbered transects. In fact, the 1997 shoreline maps and data tables should be recycled or otherwise disposed of now that the new maps are completed. Also, for both studies, the index map is divided into 91 segments. The segments that do not have ocean-facing shoreline were not mapped as part of the Shoreline Change Project, which is why there are 76, rather than 91, total maps. The inner shorelines were not mapped because their shoreline change rates are so low over time that the visual depiction of the different shorelines would show little change.

Erosion, while a potential problem for inappropriately sited coastal development, is a natural and necessary process that provides the sand needed for the Commonwealth's beaches, dunes, and salt marshes.

HOW TO CORRECTLY INTERPRET THE DATA

To correctly interpret the shoreline change data, all shoreline data (i.e., both long- and short-term data) must be analyzed and evaluated in light of current shoreline conditions, recent changes in shoreline uses, and the affects of human-induced alterations to natural shoreline movements. In areas that show shoreline change reversals (i.e., where the shoreline fluctuates between erosion and accretion) or areas that have been extensively altered by human activities, professional judgment and knowledge of natural and human impacts are typically required for proper interpretation.

For example, a transect along Springhill Beach in Sandwich that is downdrift from a jetty shows a long-term annual erosion rate of -2.82 feet per year. From 1860-1952, the average rate of erosion at this transect was -3.74 feet per year. From 1952-1994, however, the annual erosion rate was only -0.20 feet per year. These rates show that, following construction of the jetty in 1914, there was an accelerated short-term rate of erosion. Once the shoreline adjusted to the presence of the jetty, however, the erosion rate decreased and leveled off. If the jetty was properly engineered and is properly maintained, the short-term erosion rate of -0.20 feet per year is more likely to be representative of how this shoreline is functioning currently and should be used for planning purposes, rather than the long-term rate, which dampens the effect of the jetty installation.

In contrast, an area along the southeastern shore of Nantucket exhibits a long-term annual shoreline change rate of +0.07 feet per year with a net movement of the beach of only 34.6 feet from 1846-1994. This beach is far from stable, however, as illustrated by an analysis of the short-term rates of change. Between 1846 and 1887 the beach accreted 215 feet; from 1887-1955 it eroded 12 feet; from 1955-1978 it eroded 113 feet; and from 1978-1994 this same beach eroded 56 feet. Despite the apparent long-term statistical stability of the beach, any buildings constructed on the accreting beach would have been threatened when the erosional trend returned, a situation that is presently occurring at Low Beach on Nantucket.

In addition, in many cases human attempts to stop erosion result in a change to the natural equilibrium of the shoreline. Where segments of the shoreline have been armored with sea walls and other structures to stop erosion, the shoreline change data must be looked at very closely to determine what affect these structures are having on short- and long-term erosion rates. For example, much of the sand source for Humarock Beach in Scituate has been eliminated due to seawall and revetment construction in the 1940s and 1950s. Consequently, the recent trend of erosion that began in the 1950s is not only continuing—it is accelerating.

Finally, the shoreline positions presented in the maps and data tables were compiled using several historical map and near-vertical air photographic data sources and state-of-the-art analytical techniques. The shoreline change maps produced for this report meet National Map Accuracy Standards for 1:10,000 scale mapping. Recognizing various



sources of error, this results in a positional accuracy for individual shorelines of ± 8.5 meters (28 feet). The rates of shoreline change (the focus of this project) are derived statistically from these shorelines and have a resolution of ± 0.12 meters/year (0.4 feet/year).

HOW TO USE THE SHORELINE CHANGE MAPS AND DATA

Follow the steps listed below to identify the shoreline you would like to examine and to interpret the maps and corresponding data tables:

- Locate the shoreline area you are interested in on the index map.
- Using road maps, topographic maps, and/or aerial photographs, locate the site you are interested in on the shoreline change map you selected.
- On the shoreline change map, identify the transect number(s) closest to the site of interest.
- In the corresponding data table(s), look up the transect number(s) of interest. To provide context, CZM strongly recommends that you take note of the patterns of shoreline change on either side of the transect(s) you are examining.
- From the data table(s), note the positional changes (+ denotes accretion and - denotes erosion) and the corresponding rates between each of the shoreline date(s) to determine the trends represented by each time period (e.g., constant accretion or erosion, alternating cycles of accretion or erosion, changes in the rates of accretion or erosion, etc.).
- With these numbers in mind, look at the colored shorelines on the map to identify any patterns of shoreline change in the area of interest. The magnitude and consistency (or variability) of change along the shoreline are important indicators of how dynamic the section of shoreline is, an important observation that should be considered when formulating conclusions about future shoreline positions.
- Consider any human alterations along the shoreline that may have affected sediment transport patterns in the section of interest (e.g., sea walls or other armor on the updrift coastal banks or other sediment sources, jetties at an inlet, groins along the shoreline, etc.).

- Consider the accuracy of the mapping methods and the potential error associated with them relative to the amount of change reflected in the data table(s).
- Remember that shoreline position measurements for various time periods can be used to derive quantitative estimates of the average rate of shore line change. These rates can be used to further understanding of the magnitude and timing of shoreline change in a geologic or scientific context, as well as the evolution of coastal environments in response to wave and current processes. (Note: The information depicted on the maps and in the data tables does not reflect short-term erosion that occurs during storms.)

This review will give you a good sense of how the shoreline of interest has behaved over time, and may provide an indication of future shoreline behavior. However, professional expertise is necessary when attempting to use these maps and data for planning purposes.

FOR MORE INFORMATION . . .

CZM is providing a set of maps and data tables to each coastal community, covering the shoreline within its boundaries. These materials should be available in the town or city hall, probably with the conservation commission or planning departments. In addition, copies can be viewed at the CZM Regional Offices:

NORTH SHORE - (978) 281-3972

BOSTON HARBOR - (617) 626-1174

SOUTH SHORE - (781) 545-8026 X209

CAPE COD & ISLANDS - (508) 362-1760

SOUTH COASTAL - (508) 946-8990

CZM will also have the shoreline change maps, accompanying data tables, and all supporting technical documents on its Web site at: www.mass.gov/czm. If you need a hard copy (36" x 44"), please call the CZM Information Line at (617) 626-1212.

For other coastal geology questions, contact CZM's coastal geologists at (617) 626-1200.

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CZM WEB SITE - www.mass.gov/czm



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